

REMARKS

Claims 1-4, 7, 12 and 21 are pending. Claims 5, 6 and 9-11 have been cancelled and Claims 8 and 13-20 have been withdrawn from consideration. Claims 1 and 2 have been amended. Support for the amendments can be found throughout the specification, such as, e.g., p. 1, lines 3-8, p. 3, lines 4-7, p. 5, lines 16-23 and p. 6, lines 10-20. No new matter is added. Favorable consideration of the currently pending claims is respectfully requested in light of the foregoing amendments and following remarks.

Rejections Under 35 U.S.C. §103:

In the Office Action, the Examiner rejected Claims 1-4, 7, 12 and 21 under 35 U.S.C. § 103(a) as unpatentable over Connell *et al.* (UK 1,037,144) in view of Timmons *et al.* (5,876,753) or vice versa. In addition, the Examiner rejected Claims 1-4, 7, 12 and 21 under 35 U.S.C. § 103(a) as unpatentable over Timmons *et al.* in view of Kolluri *et al.* (5,723,219). Applicants respectfully submit that the amendments to the claims overcome the Examiner's rejection.

Applicants have amended Claim 1 to recite a preferred average power density of **less than 0.0025 W/cm³**, as described on page 6, line 12 of the specification. The examples described in the specification also fall within this limitation. None of the documents cited by the Examiner disclose or suggest an average power density below 0.0025 W/cm³.

Applicants have also amended Claims 1 and 2 to positively include plasma deposition limitations and the conditions by which the deposition occurs, i.e., that the monomer is a polymerizable epoxy monomer and that polymer growth occurs on a surface of the substrate, wherein the pulsed plasma discharge is achieved by applying a power pulse to the plasma, each applied power pulse having a power off time of from 10,000 to 20,000 μ m. Applicants believe that these amendments satisfy the Examiner's comments in the Advisory Action regarding the lack of requirement for such deposition.

Applicants submit that one skilled in the art would not combine the teachings of Timmons *et al.* and either Connell *et al.* or Kolluri *et al.* to achieve the presently claimed method, because the chemistry of the monomers used by Timmons *et al.* is different to that disclosed by Connell *et al.* and Kolluri *et al.* Furthermore, Timmons *et al.* fail to define “low power,” nor do they provide a value for power density or chamber volume. Applicants respectfully submit that the limitations of Claim 1 fall well outside the range of conditions taught by Timmons *et al.* Therefore, even if the materials of Connell *et al.* or Kolluri *et al.* were subjected to the pulsing conditions disclosed by Timmons *et al.*, the limitations of Claim 1 would not be satisfied.

The process of plasma polymerization requires the careful choice of monomer and plasma conditions to provide a method where organic polymers can be deposited, as a thin-film, onto a variety of substrates. Prior to the work of applicants, it was believed that plasma chemists/physicists relied mostly on “low” (this being a relative term) powers, either continuous or pulsed, to retain monomer functionalities. However, the effect of plasma pulsing on free radical initiated polymerization has not been well understood. Applicants used monomers that are susceptible to free radical initiated polymerization (e.g., an acrylate or methacrylate). These monomers possess an unsaturated (C=C) group that will react with a radical (R') to produce RC-C'. This new radical can then add to another unsaturated group to produce a “growing” polymer chain that can further add to another unsaturated monomer.

Although the **solution** chemistry of acrylates and methacrylates is extensively documented in the literature, the **plasma** chemist (such as Timmons *et al.*) has generally ignored these types of monomers. Thus, little is known about how such monomers behave in plasma conditions. Certainly, however, Timmons *et al.* fail to mention epoxy monomers, and applicants respectfully disagree with the Examiner's position that a person skilled in the art would extend the teaching of Timmons *et al.* to monomers that are known to involve such different chemistry.

Applicants have found that a very short, low power pulse initiates such monomers and that growth of the polymer occurs during a relatively long **off** period. Thus, a high frequency pulse and short “on” time, resulting in much lower average power densities, is beneficial for the deposition of polymers, which rely substantially on free radical initiated polymerization.

As stated previously, Timmons *et al.* broadly relate to the deposition of “carbonaceous compounds having a reactive functional group.” This is considered to be an excessively broad and speculative scope, bearing in mind that the nature of the monomer is known to affect the success of deposition (column 7, line 36-37). Timmons *et al.* focus on allyl-type compounds, and although they state that the technology can be “extended to non-allyl precursors” one skilled in the art could only meaningfully interpret this to mean “related monomers” or other precursors that might be expected to react in a similar way. Allyl type monomers are **not** particularly susceptible to free radical initiated polymerization:

“Transfer to monomer is of particular importance during the polymerization of allyl ester, ethers, amines and related monomers. The allylic hydrogens of these monomers are activated towards abstraction by both the double bond and the heteroatom substituent . . . and cause the allyl monomers to retard polymerization.”

Allyl monomers, THE CHEMISTRY OF FREE RADICAL POLYMERIZATION,
G. Moad and D. Solomon, ISBN 0 08 042078 8, 1995 Pergamon.

Therefore, the chemistry occurring in the Timmons *et al.* plasma reactor is **different** from that occurring in the claimed method. For this reason, the presently claimed selection of a combination of materials and average power densities not specifically disclosed in Timmons *et al.* is considered to be a purposeful selection.

Moreover, the Connell *et al.* patent relates to a continuous wave deposition process. This clearly fails to facilitate free radical initiated polymerization in the way envisaged by the claimed method. Applicants would expect the process of Connell *et al.* to result in a deposited polymer having a very **different** structure from that produced by the

claimed process. In particular, applicants would expect it to have a significantly **higher** degree of **cross-linking**.

In addition, although Kolluri *et al.* disclose plasma deposition of epoxy polymers, the deposition of the epoxy group is provided as only **one** example of several functional groups that might be plasma deposited. Example 1 of Kolluri *et al.* includes plasma polymerization of acrylic acid as part of a multi-step process in which the functional density of the film is maximized by building a network of sequentially deposited layers rather than by selecting specific plasma conditions. Moreover, only one working example is provided. Kolluri *et al.* is directed to functional film networks containing a number of plasma-deposited layers that maximize the functional density of the film. Kolluri *et al.* provide **insufficient** disclosure as to how the pulsing conditions might affect the quality and functional density of any particular layer. The claimed method improves on Kolluri *et al.* by further reducing the average power density.

Finally, applicants note that Claim 1, as amended, now includes the limitation that the power-off time of the applied plasma pulse is “from 10,000 to 20,000 μ s.” Applicants submit that this power-off time is significantly **shorter** than the off-time derived from Example 1, step 2, of Kolluri *et al.* (pulse time 0.1 s, 10% duty cycle on:off).

Accordingly, applicants request that the rejection of Claims 1-4, 7, 12 and 21 under 35 U.S.C. § 103(a) over Connell *et al.* in view of Timmons *et al.* or vice versa be withdrawn. Applicants also request that the rejection of Claims 1-4, 7, 12 and 21 under 35 U.S.C. § 103(a) over Timmons *et al.* in view of Kolluri *et al.* be withdrawn.


CONCLUSION

Based upon the amendments and remarks provided above, applicants believe that Claims 1-4, 7, 12 and 21 are in condition for allowance. A Notice of Allowance is therefore respectfully solicited.

No additional fees are believed due; however, the Commissioner is hereby authorized to charge any additional fees that may be required, or credit any overpayment, to Deposit Account No. 11-0855.

If the Examiner believes any informalities remain in the application that may be corrected by Examiner's Amendment, or there are any other issues that can be resolved by telephone interview, a telephone call to the undersigned attorney at (404) 815-6500 is respectfully solicited.

Respectfully submitted,


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